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TABLES FOR THE MICROSCOPIC IDENTIFICATION OF INORGANIC SALTS.

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INTRODUCTION.

The identification of a salt by a qualitative chemical analysis necessarily presupposes the purity of the salt, since a qualitative analysis would make no distinction between an accidental impurity and a constitutional molecular group of the compound. But even with material of assured purity the results of the analysis would still be indefinite. Whether, for example, a substance containing K, H, and PO_4 was a monopotassium or dipotassium phosphate would be undecided. The whole question of hydrates would likewise be indeterminate. If the material qualitatively examined should be a mixture, the difficulties of identification would be insuperable by the analytical evidence alone.

If a quantitative analysis is made, the results would be sufficiently explicit in certain relatively simple cases if the material analyzed is known to be a single pure substance. But in other cases—for example, elemental sulphur—the analysis would give no evidence as to the particular allotropic form of sulphur—a point which in certain problems might be of considerable importance. Where the substance is a double salt, the analytical data would not differentiate between a double salt and a mixture of two simple salts; and the more complicated the molecular composition of the salt the more difficult would be the interpretation of the analysis. With mixed salts any calcu-

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lation of the original composition of the materials from the analytical figures would be practically out of the question in all but a relatively few and simple cases.

Even where chemical analysis, either qualitative or quantitative, gives the desired information as to the existence of a certain compound, the time consumed in making the analysis is comparatively long. A method which would give reliable and rapid identifications is obviously desirable and for certain work imperative. For instance, a chemical analysis would readily give the percentage of the various elements in a mixed fertilizer, but further data as to the actual compounds of potash, say, which are present in the sample might be necessary for certain plot or pot experiments.

A number of methods designed to furnish evidence as to the constituents of mixtures have been proposed and used in certain limited fields of study. The separation of minerals in rock powders according to their specific gravities by means of solutions of appropriate densities was long in vogue, and even now is used occasionally. Ordinary microscopical observation of crystal forms has been used extensively, and, though sometimes abused, in the hands of an expert it can be made of considerable value. Its application, however, is limited to well developed crystals, and even then it furnishes only meager data of a definitive kind. The danger attending its use becomes apparent when one tries to identify one of the numerous "needle-shaped" crystals with no more data than can be obtained with the cross hairs and possibly the rotating stage of the microscope. Microchemistry at its best gives scarcely better results than a qualitative chemical analysis. The observation of absorption spectra with a microspectroscope is of extremely limited application. Up to the present time, petrographic methods are the best and apparently the only general solution of the problem.

PETROGRAPHIC METHODS.

The possible range of application of petrographic methods to chemical problems is almost unlimited. They have been successfully applied to the identification of compounds formed in concrete and cement mixtures and to general ceramic problems. It has been found possible to differentiate between phrenosin and kerosin derived from both the brain and the soil. The alkaloids and sugars afford notable instances of the rapid identification of substances without tedious chemical procedures.[1] Most phase rule work presents problems easily solved by the petrographic microscope. This application has already found commercial use in the study of brines. In the laboratory of the Bureau of Soils it has been shown to be feasible

[1] Wherry, E. T., U. S. Dept. Agr., Bul. 679 (1918).

to identify the various substances occurring in commercial fertilizers and the salts obtained from the evaporation of soil extracts. Other minor applications have been the examination of scouring soaps, products of dye manufacture, ground glass and sand in foodstuffs, incrustations and efflorescences on buildings, gas pipes, soils, etc., chemical precipitates, miscellaneous laboratory reagents, and commercial products such as ordinary salts and carborundum. Possibly one of the widest applications may be in the inspection of drugs and similar products.

The petrographic microscope was primarily designed for the identification of natural minerals. But since minerals are nothing more than a particular group of more or less definite and usually impure chemical compounds which occur in nature, the petrographic microscope is all the more applicable to the crystalline compounds of the laboratory where purity is usually of a fairly high degree. The methods have an immense advantage over ordinary microscopic observations of crystals in that particles showing crystalline forms or outlines are not essential. The petrographic determinations are made upon the optical constants with only incidental and occasional reference to crystallographic constants, and therefore can be made upon crushed or ground fragments showing no crystalline outlines almost as well as upon well-developed crystals. Furthermore, the optical methods are accurate and certain to a degree which can not be attained in a measurement of crystals under the microscope.

The optical properties have been repeatedly described and the methods for their determination given.[2] They are isotropy, or anisotropy, uniaxiality or biaxiality, optical character, refractive indices, birefringence, optic axial angles, dispersion, color, pleochroism, absorption, orientation, and such crystallographic properties as cleavage and system where possible. Isotropy, anisotropy, uniaxiality, biaxiality, and optical character are qualitative in their nature and serve simply to throw a particular substance into a classificatory group. All the other properties are specific for a given substance and serve to identify it when once placed in its proper group. Dispersion, color, pleochroism, and absorption are essentially qualitative as usually observed. Refractive indices, birefringence, optic axial angles, and orientation are distinctly quantitative, however, and refer to specific numerical values.

[2] For an admirable and exhaustive account of methods see Johannsen, Manual of Petrographic Methods, New York, 1914. For a general critique of methods see Wright, The Methods of Petrographic-Microscopic Research, Their Relative Accuracy and Range of Application, Carnegie Institution of Washington, Pub. 158, 1911. An extremely elementary account of the simplest and most easily applied methods has been given by Fry, Identification of Commercial Fertilizer Materials, U. S. Dept. of Agr., Bul. 97, 1914. Among numerous other publications may be mentioned the classic works of Iddings, Rock Minerals, New York, 1906; Rosenbusch and Wulfing, Mikroskopische Physiographie der petrographisch wichtigen Mineralien, 1 Teil, Stuttgart, 1904; Schroeder van der Kolk, Kurze Anleitung zur Mikroskopischen Krystallbestimmung, Wiesbaden, 1898; and Larsen, U. S. Geol. Survey Bul. 679, 1921.

All of the optical properties named may usually be observed and measured where measurement is possible in about 15 minutes, with no more material than can be held upon the point of a knife blade, assuming of course that one has ready all the essential equipment for the work and is not under the time-consuming necessity of making a microscopical search for the material to be identified in a mass of other material. In certain cases, however, the time of search can be materially reduced or even eliminated. For instance, if one has a mixture of NaCl and KCl, the presence of either one but not both being known, the mass can be mounted in an oil of the same refractive index as that of the known substance, when the latter will be invisible or practically so and the unknown will stand out with a considerable degree of prominence, thus permitting ready "spotting" and a subsequent working down or up to its index with different oils. The value of this point in the rapid detection of impurities in supposedly pure substances is obvious.

EXPLANATION OF SYMBOLS.

For convenience in identification the substances have been tabulated in five groups as follows: Isotropic, uniaxial positive, uniaxial negative, biaxial positive, and biaxial negative substances. In the isotropic group the refractive index is the only property to be observed, and the arrangement of the substances is according to increasing values of the index. In the uniaxial positive and uniaxial negative groups there are two refractive indices to be measured, designated ω and ϵ, denoting respectively the ordinary and extraordinary rays of light as observed in polarized light. The difference between these two indices constitutes the birefringence of the substance. Other properties, such as pleochroism, are occasionally observable, and the crystal system should always be noted where possible. The arrangement of the substances is according to ascending values of the ω index.

In the biaxial positive and biaxial negative groups there are three refractive indices to be measured—that is, the α, β, and γ indices—indicating respectively the least, the intermediate, and the greatest index of the substances. The differences between any two of these are significant and are tabulated. The true optical angle is indicated by 2V. The symbols 2E and 2H indicate the value of this axial angle when measured in air and oil, respectively. Dispersion is tabulated as greater or less for red, ρ, than for violet, υ, light. In the columns headed "orientation," X, Y, and Z signify the directions of vibration of the α, β, and γ rays. Ax.pl. is an abbreviation for plane of the optic axes of the crystal. All the other symbols in this column are either geometrical or simple crystallographic designations of crys-

tal faces and axes. Pleochroism should be observed when present, and crystal system should always be identified where possible. The arrangement is according to ascending values of the β index.

OPTICAL PROPERTIES.

It can not be too strongly stated that geometrical and optical crystallography constitute two distinct classes of crystal investigations; closely interrelated, it is true, and mutually dependent for certain properties, but nevertheless far from being completely expressible in terms of each other. For example, a complete geometrical description of a crystal could do no more than indicate isotropy, uniaxiality or biaxiality, leaving all of the other optical properties completely undecided.

To show the relations between geometrical and optical crystallography and to explain briefly the optical terms and methods here used, the following résumé is given.

All crystals can be grouped into six major systems, each of which has numerous subdivisions or modifications. These major systems are the isometric, tetragonal, hexagonal, orthorhombic, monoclinic, and triclinic. Optically, these may be grouped into two classes, depending upon the mode of transmission of light in them in different directions. Substances belonging to the isometric system transmit light with equal speed, regardless of crystallographic directions. They therefore act very much as a piece of glass or other amorphous body. Such substances form the isotropic class. All belonging to the other systems transmit light with a speed which varies as the direction through the crystal varies. These form the anisotropic, doubly refracting, or birefringent class.

Anisotropic materials comprise two main groups, the first having only one optic axis, and the second having two. These are the uniaxial and biaxial groups, respectively. The uniaxial groups include the tetragonal and hexagonal systems, and the biaxial group the orthorhombic, monoclinic, and triclinic systems. The uniaxial and biaxial groups are further subdivided into optically positive and optically negative subgroups.

We therefore have an optical classification as follows:

Isotropic		Isometric system.	
Anisotropic	Uniaxial	Tetragonal, Hexagonal	Positive.
			Negative.
	Biaxial	Orthorhombic, Monoclinic, Triclinic	Positive.
			Negative.

Since light is not modified by the direction in which it traverses an amorphous or isometric substance, there is only one optical prop-

erty, aside from isotropy, which is to be determined; that is, the refractive index.

Since light, in passing through anisotropic media, is always doubly refracted, this group presents complications of refractive index and other determinable phenomena, all of which have diagnostic value.

Uniaxial crystals have two refractive indices, one of the rays vibrating parallel to the optic axis and another at right angles to this direction. Biaxial crystals have three indices, two lying in one plane and the third in another plane of the particle. Not only is each index of diagnostic value; but also the differences between the indices of a given substance, since these differences are a measure of the double refraction and therefore of the order of the interference colors shown between crossed nicols. Furthermore, the plus or minus value of the difference of the indices of rays vibrating in given directions determines the optically positive or optically negative character of the substance. If $\epsilon > \omega$ in a uniaxial substance, the substance is optically positive; if the reverse is true, negative. In biaxial substances, if $\beta - \alpha$ is decidedly greater than $\gamma - \beta$ the substance is optically negative, and if the reverse is true, positive.

Biaxial substances, suitably oriented, show the emergence of two optic axes, and the angle between these two axes is called the optic angle. Uniaxial materials may be considered as the limiting case of the biaxial group where the optic angle is zero.

Frequently red light is dispersed more or less than violet light, and this fact is of diagnostic value.

In any given substance other than amorphous or isometric there is always a specific relation between the directions of the optic axes or planes and the crystallographic axes, and therefore between the optic axes or planes and any given external face or line on the crystal. In other words, a given substance lying in a particular crystallographic position will always show the same value and orientation of its optical properties, whereas a change in the crystallographic position would usually change the orientation and might change the value of some given property—apparent refractive index, for example.

The absorption of certain colors of light in one optical direction in a crystal to a greater or less extent than in another direction gives rise to a change in color of the material depending upon the direction in which it is viewed. This is called pleochroism, and is characteristic of certain compounds.

The measurement of the refractive index is based on the principle that the contact between two substances of the same color and refractive index is invisible and the greater the difference between the indices of the two substances the more prominently one stands out from the other. If a substance is mounted in an oil of known refractive index, either the method of central or the method of in-

clined illumination may be used to determine whether the substance has an index higher or lower than that of the oil. This determined, the substance is mounted in another oil of appropriately higher or lower index, as the case may be, and the operation repeated. By this method of trial and error, an oil is found in which the given substance disappears. The refractive index of the substance is then the same as that of the oil. A little practice enables one to estimate quite closely the index of a substance observed in an oil of a definite but different index, and this estimation very materially reduces the number of trials that must be made before the correct oil is found.

The preceding description applies directly to the measurement of the refractive index of an isotropic substance. In the measurement of the indices of anisotropic substances, the problem is complicated by the fact that the index of the substance varies as the direction of the vibration of the light varies. With anisotropic substances, it is therefore necessary to ascertain carefully the optical orientation of all particles upon which the measurements are carried out. On a given substance in the proper orientation one index may be determined directly. A second index is in the same plane and consequently may be determined by a change in the orientation of the substance represented by simple rotation of the stage of the microscope. The third index must be measured upon the substance in another plane represented by a tilting of the grain. This tilting may be accomplished by a universal stage attachment on the microscope or by moving the cover glass, as, for example, with the point of a pencil. In the measurement of indices of anisotropic substances, regard to optical orientation is more often than not a considerable aid in identification.

Whether a given crystal is isotropic or anisotropic—that is, whether it is isometric or belongs to one of the other crystalline systems—is readily determined by crossing the nicol prisms of the microscope. Isotropic substances transmit no light under these conditions; whereas anisotropic substances, being doubly refractive, do transmit light and are readily visible. In making this test care must be taken that an anisotropic uniaxial substance is not so oriented that the line of vision is parallel to the optic axis of the substance and that no particles are observed only at their point of extinction. Tilting the grain and revolving the stage of the microscope will eliminate both of these possibilities of error. If the substance is known to be biaxial, simple revolution of the stage is sufficient.

Uniaxiality or biaxiality is established by converting the microscope into a conoscope by crossing the nicols and removing the ocular or by inserting the Bertrand lens and observing the interference figure of the particle in question. Uniaxial substances show a cross, if lying on a plane perpendicular to the optic axis. As the particle is tilted more and more out of this position the center of the cross finally is out

of the field of the microscope and only the arms of the cross are visible, each one coming into view separately and at right angles to the other as the stage of the microscope is revolved. In the limiting case where the particle is lying on a plane parallel to the optic axis the interference figure is practically indeterminate and the position of the grain must be altered.

Biaxial substances lying on a plane perpendicular to the acute bisectrix of the optic axes show the points of emergence of the two optic axes, which points mark the loci of two hyperbolæ, extending in opposite directions and momentarily coming together in the form of a cross as the stage is revolved. As the particle is tilted out of its perpendicular position one or other of the points of emergence first leaves the field of the microscope, only one hyperbola remaining in view. As the tilting continues this second point of emergence likewise leaves the field; but biaxiality is still evidenced by the curved portion of the hyperbola remaining in view. In the limiting case where the particle lies in a plane parallel to the plane of its optic axes, the interference figure is indeterminate and the position of the particle must be altered. In case there is a large acute angle between the two optic axes, both points of emergence are out of the field when the particle is in the perpendicular position. In such a case only one point of emergence can be observed at a time, and tilting is necessary.

If the interference cross of a uniaxial substance, or the interference figure, preferably revolved into the form of a cross, of a biaxial substance, be observed and a gypsum plate showing red of the first order be inserted, two opposite quadrants of the figures become blue in color and the other two opposite quadrants become yellow. The position of the quadrants colored blue and yellow establishes the optically negative or positive character of the substance under examination; but it is necessary to calibrate each microscope and gypsum plate as to the position of the colored quadrants. This can readily be done once for all by observation of a piece of muscovite. This mineral, being optically negative, gives the phenomena characteristic of negative substances. For positive substances the phenomena are simply reversed. In case the interference figures are highly colored, a quartz wedge may conveniently be used in place of the gypsum plate. But here, instead of noting the coloration of the quadrants, one must note the movement of the colored bands into or away from the center of the figure in the different quadrants as the wedge is slowly inserted. The bands in two opposite quadrants move in to the center and away from the center in the other quadrants. Here, as with the gypsum plate, the microscope must be first calibrated. Muscovite will serve very well for this purpose, a fairly thick piece showing the phenomena.

If the refractive indices have been determined with sufficient accuracy, the double refraction is simply their arithmetical difference. But it is sometimes desirable to determine the value experimentally. This can be done with the quartz wedge and an appropriate map of interference colors, such as is given in several of the textbooks referred to on page 3. For further details the references must be consulted.

Dispersion means simply that the axial angle is greater or less for red than for violet light. This may be determined by a measurement of the axial angles with lights of these two colors: but usually it is quite sufficient simply to observe the position of the colors in the interference figures. If both the hyperbolæ have the same dispersion, then a reddish color should be noted on the concave and a bluish color on the convex side of the hyperbola if $\rho < \nu$ and the reverse if $\rho > \nu$.

The orientation of a crystal is simply a statement of the relation of the optic directions and planes to the crystallographic axes and faces, and necessarily presupposes familiarity with and the possibility of identifying the crystallographic forms. This identification is not always possible with rounded or broken grains showing no crystalline outlines. In certain cases, however, the position of the crystallographic axes can be established by the optical data, and vice versa.

In compiling the tables an effort has been made to gather together all substances for which the optical constants are known with any degree of completeness and accuracy. It has been found necessary to eliminate a large amount of material for which the data are too meager to be of any real value. Especially was this so in the tables made by Bolland.[3] In many cases he failed to specify the particular hydrate of the salt he described or even note whether it was hydrous or anhydrous. It is hoped later on to take up these incomplete data in other publications treating of the differentiation of salts of known chemical groups. The main mass of data has been taken from Groth's "Chemische Krystallographie," (2 vols., Leipzig, 1906 and 1908), and from the pages of the Zeitschrift für Krystallographie und Mineralogie. Except for a very few common substances, all naturally occurring salts have been eliminated: for them reference should be made to the admirable tables of Larsen. Except where otherwise noted, all optical constants refer to measurements with the D line of the spectrum.

[3] Monatsh. für Chemie, 31:387-419 (1910).

TABLES.

TABLE 1.—*Isotropic Substances.*

Substance.	Refractive index n_D.
NaF [a]	1.336
$(NH_4)_2SiF_6$	1.3696
CaF_2	1.4339
$NaAl(SO_4)_2.12H_2O$	1.4388
$2Na_2PO_4.NaF.19H_2O$	1.4519
$NH_3(CH_3)Al(SO_4)_2.12H_2O$	1.4541
$KAl(SO_4)_2.12H_2O$	1.4562
$RbAl(SO_4)_2.12H_2O$	1.4566
$CsAl(SO_4)_2.12H_2O$	1.4587
63½ p. ct. ammonium alum+36½ p. ct. potassium alum	1.4586
$NH_4Al(SO_4)_2.12H_2O$	1.4594
$RbTi(SO_4)_2.12H_2O$	1.462–1.465 (red).
$RbIn(SO_4)_2.12H_2O$	1.4638
$CsGa(SO_4)_2.12H_2O$	1.4649
$CsIn(SO_4)_2.12H_2O$	1.4652
$KGa(SO_4)_2.12H_2O$	1.4653
$RbGa(SO_4)_2.12H_2O$	1.4658
$NH_4In(SO_4)_2.12H_2O$	1.4664
$NH_4Ga(SO_4)_2.12H_2O$	1.4684
$2Na_2AsO_4.NaF.19H_2O$	1.4693
$CaTi(SO_4)_2.12H_2O$	1.4736
$CsMn(SO_4)_2.12H_2O$	1.479–1.487 (red).
$KAl(SeO_4)_2.12H_2O$	1.4801
$CsCr(SO_4)_2.12H_2O$	1.4810
$KCr(SO_4)_2.12H_2O$	1.4814
$RbCr(SO_4)_2.12H_2O$	1.4815
$KFe(SO_4)_2.12H_2O$	1.4817
$RbFe(SO_4)_2.12H_2O$	1.4823
$CsFe(SO_4)_2.12H_2O$	1.4839
$NH_4Cr(SO_4)_2.12H_2O$	1.4842
$NH_4Fe(SO_4)_2.12H_2O$	1.4854
KCl	1.4903
RbCl	1.4930
Thallium alum+3 p. ct. potassium alum	1.4964
$TlAl(SO_4)_2.12H_2O$	1.4976
$RbRh(SO_4)_2.12H_2O$	1.5004–1.5023
$TlGa(SO_4)_2.12H_2O$	1.5066
$RbFe(SeO_4)_2.12H_2O$	1.5070
$CsRh(SO_4)_2.12H_2O$	1.5077
$NH_4Rh(SO_4)_2.12H_2O$	1.5103
$CsFe(SeO_4)_2.12H_2O$	1.5116
$Na_3(MgCl)(CO_3)_2$	1.5144
$NaClO_3$	1.5151
$TlCr(SO_4)_2.12H_2O$	1.5228
$2Na_3VO_4.NaF.19H_2O$	1.5230
$TlFe(SO_4)_2.12H_2O$	1.5236
$Na_3VO_4.10H_2O$	1.5305
$K_2Mg_2(SO_4)_3$	1.5329
NaCl	1.5442
$TlRh(SO_4)_2.12H_2O$	1.5480
RbBr	1.5530
KBr	1.5590
$Sr(NO_3)_2$	1.5667
$Ba(NO_3)_2$	1.5717
$NaBrO_3$	1.5943
CsCl	1.6418
NH_4Cl	1.6420
RbI	1.6474
K_2SnCl_6	1.6574
KI	1.6770
CsBr	1.6984
NH_4I	1.7031
MgO	1.7364
As_2O_3	1.7550
$Pb(NO_3)_2$	1.7838
CsI	1.7876
AgCl	2.0710
Sb_2O_3	2.0870
P (yellow)	2.1168
NiO	(red) 2.180; (blue) 2.390
CuI	2.3460
ZnS	2.3892
Cu_2O	2.7050
Si	3.7390

[a] Personal communication, G. L. Keenan.

TABLE 2.—*Uniaxial Positive Substances.*

Substance.	System.	ω_D	ϵ_D	$\epsilon-\omega$
$MgSiF_6.6H_2O$	Trig.	1.3439	1.3502	0.0063
$MnSiF_6.6H_2O$	Trig.	1.3570	1.3742	.0172
$FeSiF_6.6H_2O$	Trig.	1.3738	1.3848	.0210
MgF_2	Tetrag.	1.3780	1.3897	.0117
$CoSiF_6.6H_2O$	Trig.	1.3817(C)	1.3872(C)	.0055
$ZnSiF_6.6H_2O$	Trig.	1.3824	1.3956	.0132
$NiSiF_6.6H_2O$	Trig.	1.3910	1.4066	.0156
$Na_3PO_4.12H_2O$	Trig.	1.4458	1.4524	.0066
$K_2S_2O_6$	Trig.	1.4550	1.5153	.0603
$Na_3AsO_4.12H_2O$	Trig.	1.4567	1.4662	.0095
$Rb_2S_2O_6$	Trig.	1.4574	1.5078	.0504
$NaK_3(SO_4)_2$	Trig.	1.4901	1.4996	.0095
$Na_3VO_4.12H_2O$	Trig.	1.5095	1.5232	.0137
$Na_3VO_4.10H_2O$	Hexag. modification	1.5398	1.5475	.0077
$Fe_2(SO_4)_3.9H_2O$	Ditrig.	1.5519	1.5575	.0056
$MgPt(CN)_4.7H_2O$ [a]	Tetrag.	1.553–	1.553+	Very weak.
$Mg(OH)_2$	Trig.	1.5590 (red).	1.5795 (red).	.0205
$Ca(CeF)_2(CO_3)_3$	Dihex.	1.5690	1.6700	.101
$MgSnCl_6.6H_2O$	Trig.	1.5885	1.5970	.0085
K_4CdCl_6	Ditrig.	1.5906	1.5907	.0001
$(NH_4)_4CdCl_6$	Ditrig.	1.6038	1.6042	.0004
$CaSiO_3$ [b]	Hexag. modification	1.6150	1.6360	.021
$PbS_2O_6.4H_2O$	Trig.	1.6351	1.6531	.0180
$(NH_4)_2PdSO_3Cl_3.H_2O$ [c]	Trig.	1.6430		Strong.
Li_2SiO_3 [d]	Rhomb.	1.65	1.67	.02
Be_2SiO_4	Rhomb.	1.6542	1.6700	.0158
$4NH_3.IrCl_3.H_2O$	Trig.	1.6576	1.6666	.0090
CuH_2SiO_4	Rhomb.	1.6580	1.7079	.0499
$P(C_2H_5)_4I$	Trig.	1.6600 (orange).	1.6680 (orange).	.008
$CaCeF(CO_3)_2$	Trig.	1.6742	1.7701	.0959

[a] Strong pleochroism; ⊥ opt. ax. more, ∥ axis less bluish.
[b] Anomalously biaxial, but always with very small ax. angle.
[c] ω Reddish yellow; ε dark carmine red.
[d] Indices approximate.

TABLE 2.—*Uniaxial Positive Substances*—Continued.

Substance.	System.	ω_D	ϵ_D	$\epsilon-\omega$
BeO	Hex.	1.7190	1.7330	.014
$K_3Na(CrO_4)_2$	Trig.	1.7278	1.7361	.0083
$AgBrO_3$	Ditetrag.	1.8466	1.9200	.0734
Hg_2Cl_2	Ditetrag.	1.9733	2.0559	.08265
$(PbCl)_2CO_3$	Tetrag.	2.1140	2.1400	.0260
AgI	Hex.	2.230		Weak
CdS	Hex.	2.552 (red). 2.688 (green).		Weak.
SiC	Ditrig.	2.78 0	2.8320	.046
HgS	Trig.	2.8540 (red).	3.2010 (red).	.347

TABLE 3.—*Uniaxial Negative Substances.*

Substance.	System.	ω_D	ϵ_D	$\omega-\epsilon$
Na_2SiF_6 [a]	Hex.	1.300	1.296	0.004
$CuSiF_6.6H_2O$ [b]	Trig.	1.4092	1.4080	.0012
$CaCl_2.6H_2O$	Trig.	1.417	1.393	.024
$LiKSO_4$	Hex.	1.4715	1.4721	−.0006
$BeSO_4.4H_2O$	Tetrag.	1.4720	1.4395	.0325
$Pb_4(PbCl)(AsO_4)_3$	Hex.	1.474 (red)	1.465 (red)	.009
$4Na_2SO_4.Na_2CO_3$	Hex.	1.4807	1.4614	.0193
$Sr(OH)_2.8H_2O$	Tetrag.	1.4991	1.4758	.0233
KH_2PO_4	Tetrag.	1.5095	1.4684	.0411
$NiSO_4.6H_2O$ [c]	Tetrag. Modification.	1.5109	1.4873	.0236
$K_2Cu(CN)_4$	Trig.	Mean n 1.5215		Very weak.
$(NH_4)H_2PO_4$	Tetrag.	1.5246	1.4792	.0454
$ZnSeO_4.6H_2O$	Tetrag.	1.5291	1.5039	.0252
$SrS_2O_6.4H_2O$	Trig.	1.5296	1.5252	.0044
$SrCl_2.6H_2O$ [d]	Trig.	1.5364	1.4866	.0498
$NiSeO_4.6H_2O$	Tetrag.	1.5393	1.5125	.0268
$CaS_2O_6.4H_2O$	Trig.	1.5486		
KH_2AsO_4	Tetrag.	1.5574	1.5179	.0495
$(NH_4)H_2AsO_4$	Tetrag.	1.5700	1.5217	.0549
$NaNO_3$	Ditrig.	1.5874	1.3361	.2513
$(NH_4)_4Fe(CN)_6.2NH_4Cl.3H_2O$	Trig.	1.6108	1.5922	.0176
$K_2CuCl_4.2H_2O$ [e]	Ditetrag.	1.6365	1.6148	.0217
$Ca(OH)_2$	Hex.	1.644	1.446	.198
$CaCO_3$	Trig.	1.65837	1.4864	.17197
$4(NH_4)_2S_2O_3.AgBr.NH_4Br$	Tetrag.	1.6700	1.6241	.0459
$CaMg(CO_3)_2$	Rhomb.	1.68174	1.50256	.17918
$AlClSO_4.6Cu(OH)_2.3H_2O$ [f]	Ditrig.	1.694 (green)	1.641 (green)	.053
$MgCO_3$	Trig.	1.717	1.515	.202
$LiNO_3$ [g]	Trig.	1.735	1.435	.300
$Na_{16}Cu_2Ag_4(S_2O_3)_8.6NH_3$ [h]	Tetrag.		1.7 (approx.)	
$(NH_4)_2CuCl_4.2H_2O$	Ditetrag.	1.744	1.724	.020
$BaAg_2Cs_2(NCS)_7$	Ditetrag.	1.7761	1.6788	.0973
Cs_2TlCl_5	Hex.	1.784	1.774	.010
$K_2PtI_2(NO_2)_2.2H_2O$ [i]	Ditetrag.	1.7909	1.6527	.1382
$BaCu_2Cs_2(NCS)_7$	Ditetrag.	1.8013	1.6882	.1131
Ag_2HPO_4	Trig.	1.8036	1.7983	.0053
$ZnCO_3$	Trig.	1.818	1.6177	.2003
$MnCO_3$	Trig.	1.82	1.5973	.2227
$SrCu_2Cs_2(NCS)_7$	Ditetrag.	1.8765	1.6882	.1883
$FeCO_3$	Trig.	1.873	1.633	.240
$CaWO_4$	Tetrag.	1.9345 (red)	1.9185 (red)	.0160
$K_2H_2TeI_2O_{10}.2H_2O$	Trig.	2.1 21	2.0.00	.1121
$PbWO_4$	Tetrag.	2.1685	2.182	.0865
$PbMoO_4$	Tetrag.	2.402 (red)	2.304 (red)	.098
$MnTiO_3$ [j]	Rhomb.	2.451	2.27	.271
Ag_3SbS_3	Trig.	3.084 (Li.)	2.881 (Li.)	.203
Ag_3AsS_3 [k]	Trig.	3.0877	2.7924	.2953

[a] Indices determined by Duc de Chaulnes method.
[b] Color deep blue.
[c] Color emerald green
[d] Bolland gives 1.50, 1.52, 1.545 for n.
[e] Greenish blue. Pleochroism: Grass green, sky blue.
[f] Pleochroism weak: Green, blue-green.
[g] Personal communication, Dr. E. T. Wherry.
[h] Color deep blue. Pleochroism: Pale sapphire blue, deep cobalt blue.
[i] Color reddish yellow. Pleochroism: ∥ Chief axis greenish yellow, ⊥ orange.
[j] Color deep blood red. No distinct pleochroism.
[k] Pleochroism: Blood red, cochineal red.

TABLE 4.—*Biaxial positive substances.*

Substance.	System.	α_D	β_D	γ_D	$\gamma - \alpha$	$\gamma - \beta$	$\beta - \alpha$	Optical angle.	Dispersion.	Orientation.
$KH_2Mg_2B_{11}O_{20}.6H_2O$ (?)	Mon...	1.354						2H=[illegible]°		{Ax. pl. ⊥b(010). {Z∧c=64½° in obtuse ∠β.
Na_3AlF_6	Mon...		1.364		Weak.	Weak.	Weak.	2E=59° 24′ (yellow).		{Ax. pl. ⊥ (010). {Z∧c=43° 54′ in acute ∠β.
$NaHPO_3.2\frac{1}{2}H_2O$	Mon...	1.4193	1.4339	1.4493	0.0300	0.0184	0.0116	2V (calc.)=77° 46′. 2V (obs.)=77° 38′.		{Ax. pl. b(010). {Z∧c=54° 33′ in acute ∠β.
$Na_2HPO_4.7H_2O$	Mon...	1.4412	1.4424	1.4526	.0114	.0102	.0012	{2V=38° 50′ Na... {2V=57° 18′ Na...	Not perceptible.	{Ax. pl. ⊥b(010). {Z∧c=72° in acute ∠β.
$Na_2HPO_3.5H_2O$	Ortho.		1.4434		Weak.	Weak.	Weak.	2V=44° 7′		{Ax. pl. c(001). {Z∥a.
$Na_4P_2O_7.10H_2O$	Mon...	1.4499	1.4525	1.4604	.0105	.0079	.0026	{2V=60° 29′... {2V=94° 7′...	Weak	{Ax. pl. ⊥b(010). {Z ⊥c(001).
$K_2Mg(SO_4)_2.6H_2O$	Mon...	1.4607	1.4629	1.4755	.0148	.0126	.0022	{2V=47° 54′... {2V=72° 47′...		{Ax. pl. b(010). {Z∧c=103° 38′; Z∧a=1° 10′.
$Na_2HAsO_4.7H_2O$	Mon...	1.4622	1.4658	1.4782	.0160	.0124	.0036	{2V=77° 7′... {2V=88° 59′...	Very small	{Ax. pl. ⊥b(010). {Z∧c=65° in acute ∠β.
$K_2S_2O_8$	Tric...	1.4609	1.4669	1.5657	.1048	.0988	.0060	2V=29° 32′		
$Rb_2Mg(SO_4)_2.6H_2O$	Mon...	1.4672	1.4689	1.4779	.0107	.0090	.0017	{2V=48° 46′... {2V=74° 40′...		{Ax. pl. b(010). {Z∧c=111° 14′; Z∧a=5° 15′.
$(NH_4)_2Mg(SO_4)_2.6H_2O$	Mon...	1.4716	1.4730	1.4786	.0070	.0056	.0014	{2V=51° 11′... {2V=79° 11′...		{Ax. pl. b(010). {Z∧c=94° 58′; Z∧a=12° 8′.
$FeSO_4.7H_2O$	Mon...	1.4713	1.4782	1.4856	.0143	.0074	.0069	2V=88° 48′	Little	{Ax. pl. b (0[illegible] {Z∧c=62° 28′ in acute ∠β.
$Rb_2Mn(SO_4)_2.6H_2O$	Mon...	1.4767	1.4807	1.4907	.0140	.0100	.0040	{2V=67° 5′... {2V=109° 57′...		{Z∧c=106° 57′; Z∧a=1° 0′. {Ax. pl. b(010).
$K_2Fe(SO_4)_2.6H_2O$	Mon...	1.4759	1.4821	1.4969	.0210	.0148	.0062	{2V=67° 7′... {2V=110° 10′...		{Z∧c=101° 57′; Z∧a=2° 35′. {Ax. pl. b(010).
$Na_4P_2O_6.10H_2O$	Mon.	1.4777	1.4822	1.5036	.0259	.0214	.0045	2V=48° 56′		{Z∧c=39½° in acute ∠β. {Ax. pl. b(010).
$K_2Zn(SO_4)_2.6H_2O$	Mon...	1.4775	1.4833	1.4969	.0194	.0136	.0058	{2V=68° 11′... {2V=112° 29′...		{Z∧c=100° 18′; Z∧a=4° 30′. {Ax. pl. b(010).
$(NH_4)_2Mn(SO_4)_2.6H_2O$	Mon...		1.484					{2V=69° 9′... {2V=114° 45′...		{Z∧c=98° 36′; Z∧a=8° 26′. {Ax. pl. b(010).
$Rb_2Cd(SO_4)_2.6H_2O$	Mon...	1.4798	1.4848	1.4948	.0150	.0100	.0050	2V=72° 26′		{Z∧c=105° 53′; Z∧a=0° 0′. {Ax. pl. b(010).
$Cs_2Mg(SO_4)_2.6H_2O$	Mon...	1.4857	1.4858	1.4916	.0059	.0058	.0001	{2V=16° 25′... {2V=22° 30′...		{Z∧c=136° 43′; Z∧a=29° 37′. {Ax. pl. b(010).
NH_4ClO_4	Ortho.		1.486					{2V=0°... {2V=112°...		{Z∥b. {Ax. pl. c(001).
$K_2Cu(SO_4)_2.6H_2O$	Mon...	1.4836	1.4864	1.5020	.0184	.0156	.0028	{2V=46° 32′... {2V=72° 7′...		{Z∧c=108° 33′; Z∧a=4° 5′. {Ax. pl. b(010).
$K_2Co(SO_4)_2.6H_2O$ *a*	Mon...	1.4807	1.4865	1.5004	.0197	.0139	.0058	{2V=68° 41′... {2V=114° 25′...		{Z∧c=100° 5′; Z∧a=4° 50′. {Ax. pl. b(010).

$Rb_2Fe(SO_4)_2.6H_2O$	Mon...	1.4815	1.4874	1.4977	.0162	.0103	.0059	$2V=73°\ 21'$ $2\ =125°\ 12'$		$Z\wedge c=107°\ 9'$; $Z\wedge a=1°\ 25'$. Ax. pl. b(010).
$Rb_2Zn(SO_4)_2.6H_2O$	Mon...	1.4833	1.4884	1.4975	.0142	.0091	.0051	$2V=73°\ 33'$ $2E=125°\ 46'$		$Z\wedge c=106°\ 43'$; $Z\wedge a=0°\ 50'$. Ax. pl. b(010).
$Rb_2S_2O_8$	Mon...	1.4812	1.4888	1.5719	.0907	.0851	.0076	$2V=35°\ 4'$	Weak $r>\rho$	$Z\wedge c=264°$ in obtuse $\angle\beta$. Ax. pl. b(010).
$Na_2H_2P_2O_6.6H_2O$	Mon...	1.4855	1.4897	1.5041	.0186	.0144	.0042	$2V=77°\ 20'$ $2\ =91°\ 22'$		$Z\wedge c=35°\ 17'$ in obtuse $\angle\beta$. Ax. pl. b(010).
$(NH_4)_2Fe(SO_4)_2.6H_2O$	Mon...		1.490					$2V=76°\ 52'$ $2\ =135°\ 42'$	$\rho>r$	$Z\wedge c=99°\ 43'$; $Z\wedge a=7°\ 5'$. Ax. pl. b(010).
$Rb_2Cu(SO_4)_2.6H_2O$	Mon...	1.4886	1.4906	1.5036	.0150	.0130	.0020	$2V=44°\ 42'$ $2\ =60°\ 5'$		$Z\wedge c=116°\ 28'$; $Z\wedge a=11°\ 10'$. Ax. pl. b(010).
$K_2Ni(SO_4)_2.6H_2O$	Mon...	1.4836	1.4916	1.5051	.0215	.0135	.0080	$2V=75°\ 16'$ $2\ =130°\ 57'$		$Z\wedge c=98°\ 42'$; $Z\wedge a=6°\ 18'$. Ax. pl. b(010).
$Rb_2Co(SO_4)_2.6H_2O$	Mon...	1.4859	1.4916	1.5014	.0155	.0098	.0057	$2V=75°\ 11'$ $2\ =130°\ 10'$		$Z\wedge c=106°\ 1'$; $Z\wedge a=0°$. Ax. pl. b(010).
$(NH_4)_2Zn(SO_4)_2.6H_2O$	Mon...	1.4888	1.4930	1.4994	.0106	.0064	.0042	$2V=70°\ 0'$ $2\ =144°\ 41'$		$Z\wedge c=96°\ 59'$; $Z\wedge a=9°\ 53'$. Ax. pl. b(010).
K_2SO_4	Ortho.	1.4935	1.4947	1.4973	.0038	.0026	.0012	$2V=67°\ 20'$ $2\ =111°\ 0'$		$Z\|c$. Ax. pl. a(100).
$Na_2S_2O_6.2H_2O$	Ortho.	1.4820	1.4953	1.5185	.0365	.0232	.0133	$2V=75°\ 44'$ $2\ =123°\ 33'$		$Z\|a$. Ax. pl. b(010).
$Rb_2Ni(SO_4)_2.6H_2O$	Mon...	1.4895	1.4961	1.5052	.0157	.0091	.0066	$2V=82°\ 0'$ $2\ =157°\ 0'$		$Z\wedge c=102°\ 38'$; $Z\wedge a=3°\ 25'$. Ax. pl. b(010).
$Cs_2Mn(SO_4)_2.6H_2O$	Mon...	1.4946	1.4966	1.5025	.0079	.0059	.0020	$2V=59°\ 57'$ $2\ =96°\ 57'$		$Z\wedge c=115°\ 27'$; $Z\wedge a=8°\ 20'$. Ax. pl. b(010).
$UO_2(NO_3)_2.6H_2O$ [b]	Ortho.		1.4967					$2V=44°\ 5'$ (red) $2\ =67°\ 6'$	$\rho>r$	$Z\|c$. Ax. pl. b(010).
$(NH_4)_2Ni(SO_4)_2.6H_2O$ [c]	Mon...	1.489	1.498	1.508	.019	.010	.009	$2V=86°\ 26'$ $2H=88°\ 45'$	$\rho<r$, $\nu>\rho$	$Z\wedge c=96°\ 6'$; $Z\wedge a=10°\ 58'$. Ax. pl. b(010).
$K_2Mg(SeO_4)_2.6H_2O$	Mon...	1.4969	1.4991	1.5139	.0170	.0148	.0022	$2V=30°\ 38'$ $2\ =61°\ 7'$		$Z\wedge c=104°\ 18'$; $Z\wedge a=3°\ 0'$. Ax. pl. b(010).
$KMgCl_3.6H_2O$	Ortho.		1.4992			Strong		$2V=69°\ 51'$ $2\ =118°\ 44'$		$Z\|c$. Ax. pl. b(010).
$Cs_2Cd(SO_4)_2.6H_2O$	Mon...	1.4975	1.5060	1.5062	.0087	.0062	.0025	$2V=67°\ 53'$ $2\ =114°\ 4'$		$Z\wedge c=116°\ 56'$; $Z\wedge a=3°\ 45'$. Ax. pl. b(010).
$(NH_4)_2S_2O_8$	Mon...	1.4981	1.5016	1.5866	.0885	.0850	.0035	$2V=21°$	Moderate $\nu>\rho$	$Z\wedge c=26\frac{1}{2}°$ in obtuse $\angle\beta$. Ax. pl. b(010).
$NH_4MgPO_4.6H_2O$	Ortho.		1.502					$2E=47°\ 30'$		$Z\|b$. Ax. pl. c(001).
$NaH_2AsO_4.2H_2O$	Ortho.	1.4794	1.5021	1.5265	.0471	.0244	.0227	$2V=89°\ 11'$		$Z\|c$. Ax. pl. b(010).
$Rb_2Mg(SeO_4)_2.6H_2O$	Mon...	1.5011	1.5031	1.5135	.0124	.0104	.0020	$2V=47°\ 3'$ $2E=73°\ 34'$		$Z\wedge c=106°\ 24'$; $Z\wedge a=1°\ 10'$. Ax. pl. b(010).
$Cs_2Fe(SO_4)_2.6H_2O$	Mon...	1.5073	1.5035	1.5094	.0091	.0059	.0032	$2V=71°\ 51'$ $2E=132°\ 47'$		$Z\wedge c=118°\ 17'$; $Z\wedge a=11°\ 25'$. Ax. pl. b(010).

[a] Pleochroism strong: X violet-red, Y wine yellow, Z yellowish rose.
[b] X clearest, Y greenish yellow, Z deep citron yellow. Yellow green fluorescence.
[c] Absorption $(Z=Y)>X$.

TABLE 4.—*Biaxial positive substances*—Continued.

Substance.	System.	α_D	β_D	γ_D	$\gamma-\alpha$	$\gamma-\beta$	$\beta-\alpha$	Optical angle.	Dispersion.	Orientation.
$Cs_2Zn(SO_4)_2.6H_2O$	Mon...	1.5022	1.5048	1.5093	.0071	.0045	.0026	2V=74° 11′ 2E=130° 35′		Z∧c=120° 16′; Z∧a=13° 15′ Ax. pl. b(010).
$Cs_2Cu(SO_4)_2.6H_2O$	Mon...	1.5048	1.5061	1.5153	.0105	.0092	.0013	2V=43° 24′ 2E=68° 5′		Z∧c=132° 57′; Z∧a=26° 47′. Ax. pl. b(010).
$Na_2S_2O_3.5H_2O$	Mon...	1.4886	1.5079	1.5360	.0474	.0281	.0193	2V=80° 46′ 2E=154° 7′		Z∥b. Ax. pl. ⊥b(010). Z∧c=40° 58′ in acute ∠β.
$Cs_2Co(SO_4)_2.6H_2O$	Mon...	1.5057	1.5085	1.5132	.0075	.0047	.0028	2V=81° 34′ 2E=156° 40′		Z∧c=116° 8′; Z∧a=9° 0′. Ax. pl. b(010).
$(NH_4)_2Mg(SeO_4)_2.6H_2O$	Mon...	1.5070	1.5093	1.5169	.0099	.0076	.0023	2V=54° 47′ 2E=88° 1′		Z∧c=90° 13′; Z∧a=16° 14′. Ax. pl. b(010).
$Na_2Ca(CO_3)_2.2H_2O$	Ortho.	1.5043	1.5093	1.5751	.0708	.0658	.0050	2V=31° 26′ 2E=48° 14′		Z∥b. Ax. pl. (001).
Rb_2SO_4	Ortho.	1.5131	1.5133	1.5144	.0013	.0011	.0002	2V=33° 0′ 2E=46° 20′		Z∥a. Ax. pl. c(001).
$Th(SO_4)_2.8H_2O$	Mon...		1.5168		Very weak.			2V=76° 20′	Small ρ < ν	Z∧c=65° in obtuse ∠β. Ax. pl. b(010).
$Cs_2Mg(SeO_4)_2.6H_2O$	Mon...	1.5178	1.5179	1.5236	.0058	.0057	.0001	2V=18° 35′ 2E=27° 27′		Z∧c=126° 47′; Z∧a=20° 30′. Ax. pl. b(010).
$K_2Zn(SeO_4)_2.6H_2O$	Mon...	1.5121	1.5181	1.5335	.0214	.0154	.0060	2V=66° 15′ 2E=112° 17′		Z∧c=99° 9′; Z∧a=5° 3′. Ax. pl. b(010).
$K_2Co(SeO_4)_2.6H_2O$	Mon...	1.5135	1.5195	1.5358	.0223	.0163	.0060	2V=63° 52′ 2E=106° 58′		Z∧c=100° 45′; Z∧a=3° 25′. Ax. pl. b(010).
$MgHPO_4.3H_2O$	Ortho.		1.5196					2V=44° 47′ 2E=70° 20′		Z∥c. Ax. pl. b(010).
$RbNO_3$	Ortho.	1.51	1.52	1.524	Weak.			Very small	ρ < ν	Z∥c. Ax. pl. b(010).
$Rb_2Zn(SeO_4)_2.6H_2O$	Mon...	1.5162	1.5222	1.5331	.0169	.0109	.0060	2V=75° 8′ 2E=138° 0′		Z∧c=103° 13′; Z∧a=2° 3′. Ax. pl. b(010).
$CaSO_4.2H_2O$	Mon...	1.5205	1.5226	1.5296	.00916	.00702	.00214	2V=58° 5′		Z∧c=75° 15′ in obtuse ∠β. Ax. pl. b(010).
$(NH_4)_2SO_4$	Ortho.	1.5209	1.5230	1.5330	.0121	.0100	.0021	2V=52° 12′ 2E=84° 6′		Z∥a. Ax. pl. b(010).
$K_3Cr(CN)_6$	Mon...	1.5221	1.5244	1.5373	.0152	.0129	.0023	2E=73° 32′		Z nearly ∥c. Ax. pl. b(010).
$K_2Ni(SeO_4)_2.6H_2O$	Mon...	1.5199	1.5248	1.5339	.0140	.0091	.0049	2V=72° 56′ 2E=129° 56′		Z∧c=97° 56′; Z∧a=6° 57′. Ax. pl. b(010).
$(NH_4)_2Fe(SeO_4)_2.6H_2O$	Mon...	1.5201	1.5260	1.5356	.0155	.0096	.0059	2V=76° 88′ 2E=142° 50′		Z∧c=96° 50′; Z∧a=9° 23′. Ax. pl. b(010).
$Na_4Fe(CN)_6.12H_2O$ [d]	Mon...	1.5193	1.5295	1.5436	.02432	.01410	.01022	2V=81° 25′		Z∧c=74° in obtuse ∠β. Ax. pl. (010).
$(NH_4)_2Zn(SeO_4)_2.6H_2O$	Mon...	1.5240	1.5300	1.5385	.0145	.0085	.0060	2V=82° 7′ 2E=170° 0′		Z∧c=93° 24′; Z∧a=12° 50′. Ax. pl. b(010).
$(NH_4)_2Co(SeO_4)_2.6H_2O$	Mon...	1.5246	1.5311	1.5396	.0150	.0085	.0065	2V=82° 1′		Z∧c=92° 41′; Z∧a=13° 42′ Ax. pl. b(010).

$6aS_2O_6.4H_2O$	Mon.		1.532 (red).				{2V = 87° 20′ (red) / 2V = 8 9 ° 4 2 ′ (green).	...	{Ax. pl. ⊥(010) and very nearly ∥ (201).
$MgCd_2Cl_6.12H_2O$	Ortho.		1.533	1.5769		.0438	Very large.	Small $\rho > \nu$.	{Z∥c. / Ax. pl. a(100).
$Al(OH)_3$	Mon.	1.5347	1.5347	1.5577	.0230	.0230	Small		{Ax. pl. ⊥(010). / Z in (010)
$Cs_2Zn(SeO_4)_2.6H_2O$	Mon.	1.5326	1.5362	1.5412	.0086	.0050	.0036	{2V = 83° 6′ / 2E = 166° 6′	{Ax. pl. b(010). / Z ∧ c = 111° 57′; Z ∧ a = 5° 46′.
$(NH_4)_2Ni(SeO_4)_2.6H_2O$	Mon.	1.5291	1.5372	1.5466	.0175	.0094	.0081	2V = 86° 14′.	{Ax. pl. b(010). / Z ∧ c = 89 ∠ 24′; Z ∧ a = 16° 55′.
K_2SeO_4		1.5352	1.5390	1.5446	.0094	.0056	.0038	{2V = 76° 50′ / 2E = 146° 53′	{Ax. pl. a(100). / Z ∥ c.
$(Nd,Pr)_2(SO_4)_3.8H_2O$	Mon.	1.5392	1.5479	1.5592	.0200	.0113	.0087	2V = 84° 10′.	Z ∥ b.
$Y_2(SO_4)_3.8H_2O$	Mon.	1.5453	1.5490	1.5755	.0322	.0265	.0057	{2V = 50° 43′ / 2E = 83° 6′	{Ax. pl. ⊥b(010). / X almost exactly ⊥c(001).
$Pr_2(SO_4)_3.8H_2O$	Mon.	1.5399	1.5494	1.5607	.0208	.0113	.0095	2V = 85° 27′.	{Ax. pl. ⊥b(010) and almost exactly ⊥c(001). / Z ∥ b.
$Nd_2(SO_4)_3.8H_2O$	Mon.	1.5413	1.5505	1.5621	.0208	.0116	.0092	2V = 83° 57′.	{Ax. pl. ⊥b(010). Z ∥ b. / X almost exactly ⊥c(001).
$K_3Rh(CN)_6$	Mon.	1.5498	1.5513	1.5634	.0136	.0121	.0015	{2V = 39° 1′ / 2E = 63° 35′	{Ax. pl. b(010). / Z nearly ∥ c.
$Sm_2(SO_4)_3.8H_2O$	Mon.	1.5427	1.5519	1.5629	.0202	.0110	.0092	2V = 85° 56′.	{Ax. pl. ⊥b(010) and nearly ⊥c(001). Z ∥ b.
Rb_2SeO_4	Ortho.	1.5515	1.5537	1.5582	.0067	.0045	.0022	{2V = 68° 53′ / 2E = 121° 20′	{Ax. pl. a(100). / Z ∥ c.
$K_3Mn(CN)_6$ *f*	Mon.	1.5527	1.5547 (Li)	1.5710	.0183	.0163	.0020	2V = 42° 53½′.	{Ax. pl. b(010). / Z almost exactly ∥ c.
$Li_2S_2O_6.2H_2O$	Ortho.	1.5487	1.5602	1.5788	.0301	.0186	.0115	{2V = 78° 16′. / 2E = 159° 45′.	{Ax. pl. c(001). / Z ∥ a.
$(NH_4)_2SeO_4$	Mon.	1.5607	1.5630	1.5846	.0239	.0216	.0023	{2V = 37° 54′. / 2E = 60° 44′.	{Ax. pl. ⊥b(010) and nearly ∥ c (001). / Z ∧ c = 113° 11′ in obtuse ∠β.
$K_2Cd(NO_2)_4$	Ortho.		1.565	1.608		.043		2E = 80° (approx.)	{Ax. pl. (100). / Z ∥ c.
$K_3Fe(CN)_6$ *g*	Mon.	1.5660	1.5689	1.5831	.0171	.0142	.0029	{2V = 49° 10′. / 2E = 81° 29′.	{Ax. pl. b(010). / Z ∧ c = 3° 53′ in obtuse ∠β.
$CaSO_4$	Ortho.	1.5693	1.5752	1.6130	.0437	.0378	.0059	2V = 43° 44½′.	{Ax. pl. b(010). / Z ∥ a.
$Ba(ClO_3)_2.H_2O$	Mon.	1.5622	1.577	1.635	.0728	.058	.0148	2V = 55° 30′.	{Ax. pl. b(010). / Z ∧ c = 23½° in acute ∠β.
$Ca_2Fe(CN)_6.12H_2O$	Tric.	1.5700	1.5818	1.5961	.0261	.0143	.0118	2V = 85° 12′.	{X nearly ⊥c(001). One optic axis nearly ⊥ b(010).
$BeBO_3(Be.OH)$	Ortho.	1.5595	1.5908	1.6311	.0716	.0403	.0313	2V = 87° 7′.	{Ax. pl. b(010). / Z ∥ c.
$K_2Cr_2O_7.Hg(CN)_2.2H_2O$	Ortho		1.594 (red).				{2V = 57° 18′. / 2E = 99° 22′.	Very strong...	{Ax. pl. a(100). / Z ∥ c.

d Y = X = Z.
e Pleochroism very weak: ∥(010) somewhat deeper colored.
f Pleochroism weak: X brick red, Y scarlet red, Z blood red.
g X orange-dawn red, Y hyacinth-cherry red, Z cherry red. Y = Z > X.

TABLE 4.—*Biaxial positive substances*—Continued.

Substance.	System.	α_D	β_D	γ_D	$\gamma-\alpha$	$\gamma-\beta$	$\beta-\alpha$	Optical angle.	Dispersion.	Orientation.
$Fe_3(PO_4)_2.8H_2O$	Mon...		1.592					2V=73° 10′		Ax. pl. ⊥(010). Z c=61½° in obtuse ∠β.
$Ca_2B_6O_{11}.5H_2O$	Mon...	1.5863	1.5920	1.6139	.02772	.02196	.00576	2V=54° 52′ 2E=95° 15′		Ax. pl. ⊥(010). Z c=8½° in obtuse ∠β.
$Na_2Ru(NO_2)_5.2H_2O$ [h]	Mon...	1.5889	1.5943	1.7163	.1274	.1220	.0054	2V=25° 14′ 2E=41° 8′		Ax. pl. b(010). Z c=81° 18′ in acute ∠β.
$BaS_2O_6.2H_2O$	Mon...	1.5860	1.5951	1.6072	.0212	.0121	.0091	2V=82° 26′		Ax. pl. b(010). Z c=1½° in acute ∠β.
$(AlO)_3BO_3$	Ortho.	1.586	1.603	1.623	.037	.020	.017	2V=87° 5′		Ax. pl. b(010). Z∥c.
$CaH_4Si_3SnO_{11}$	Ortho.	1.609	1.6125	1.619	.010	.0065	.0035	2V=69½°	$\rho > \nu$	Ax. pl. (010). Z∥c.
$SrSO_4$	Ortho.	1.6220	1.6237	1.6237	.0017			2V=51° 45′ 2E=88° 38′		Ax. pl. b(010). Z∥a.
$Na_6H_8(MoO_4)_7.18H_2O$	Mon...		1.627		Strong.			2V=84° 6′		Ax. pl. ⊥b(010). Z c=84½° in acute ∠β.
$BaSO_4$	Ortho.	1.6369	1.6381	1.6491	.0122	.0110	.0012	2V=37° 28′ 2E=65° 12′		Ax. pl. b(010). Z∥a.
$Ca_4P_2O_9$	Mon...		Mean n=1.64		Rather strong.			2V=20° (red).... 2V=40° (blue)..		Ax. pl. b(010). Z nearly ⊥c.
$BaCl_2.2H_2O$	Mon...	1.635	1.646	1.660	.025	.014	.011	2V=81° 46′		Ax. pl. (010). Z c=8° in obtuse ∠β.
$CdCl_2.2\frac{1}{2}H_2O$	Mon...		1.6513					2V=56° 27′ 2E=100° (air)... =53°30′(glass)	Imperceptible.	Ax. pl. (010). Z c=1° 40′ in obtuse ∠β.
$Mg_3(BO_3)_2$	Ortho.	1.6527	1.6537	1.6748	.0221	.0211	.0010	2E=43° 18′	Weak $\rho > \nu$	Ax. pl. b(010). Z∥c.
$Na_2SO_4.Cu_2(CuOH)_2(SO_4)_3.2H_2O$	Mon...	1.6491	1.6555	1.7143	.0652	.0588	.0064	2V=36° 48′	Strong	Z c=12° in acute ∠β. Ax. pl.=symmetry plane.
$K_2PtBr_2(NO_2)_2.H_2O$	Tric...	1.626	1.6684	1.757	.131	.0886	.0424	2V=72° 21′		Ext. angle on (20$\bar{1}$) with edge (00$\bar{1}$:20$\bar{1}$)=33°.
$BaPtCy_4.4H_2O$	Mon...	1.6704		1.8982	.22761			2E=31° 16′		Ax. pl. (010). Z c=1° 20′ in acute ∠β.
$Na_2Cr_2O_7.2H_2O$	Mon...	1.6510	1.6994	1.7510	.0900	.0516	.0384	2V=83° 42′		Ax. pl. ⊥b(010). Z c=13° in obtuse ∠β.
$SrCr_2O_7.3H_2O$	Mon...	1.7146	1.7174	1.812	.0974	.0946	.0028	2V=20° 28′ 2E=37° 26′	$\rho > \nu$	Ax. pl. b(010). Z c=78° 8′ in obtuse ∠β.
AlO.OH	Ortho.	1.702	1.722	1.750	.048			2V=84° 20′		Ax. pl. (010). Z∥a.
$BaBr_2.2H_2O$	Mon...	1.7129	1.7266	1.7441	.0312	.0175	.0137	2V=83° 49′		Ax. pl. (010). Z nearly ⊥(100). Z∧c=89° 35′ in obtuse ∠β.

$AgNO_3$	Ortho.	1.729		1.788	.059			2V=62° 16′ 2E=125° 44′	ρ > ν	Ax. pl. a(100). Z∥c.
$K_2Cr_2O_7$	Tric.	1.7202	1.7380	1.8197	.0995	.0817	.0178	2V=51° 53′ 2E=98° 58′		Ax. pl. nearly ⊥c(001).
$MgW_4O_{13}.8H_2O$	Mon.		1.74					2V=77° 50′	Weak ρ > ν	Ax. pl. ⊥b(010). X∧c=66° in acute ∠β.
$Na_2Si_2(9/11Ti,2/11Zr)_2O_9$	Ortho.	1.7431		1.7876	.0445			2E=72°		Ax. pl. (100). Z∥b.
$Sr_2W_{12}SiO_{10}.16H_2O$	Mon.		1.749		Rather strong.			2V=86° 30′	Very strong. ρ > ν	Ax. pl. ⊥b(010). Z∧c=17° in acute ∠β.
Tl_2SO_4	Ortho.	1.8600	1.8671	1.8853	.0253	.0182	.0071	2V=68° 4′ 2H=77° 43′		A=γ, b=β, c=α. Z∥a; X∥c. Ax. pl. b(010).
$PbSO_4$		1.8771	1.8823	1.8937	.0166	.0114	.0052	2V=75° 24′		Ax. pl. b(010). Z∥a.
S	Ortho.	1.9579	2.0377	2.2452	.28725	.20746	.07979	2V=68° 58′		Ax.pl. b(010). Z∥c.
$PbCl_2$	Ortho.	2.1992	2.2172	2.2596	.0604	.0424	.0180	2V=66° 12′		Ax.pl. b(010). Z∥a.
$PbCrO_4$			2.42		Extraordinarily strong.			2V=54°	Weak ρ > ν	Ax.pl. b(010). Z c=5½ in obtuse ∠β.

[h] Vibration ∥ Z, orange; ∥X, yello w

TABLE 5.—*Biaxial negative substances.*

Substance.	System.	α_D.	β_D.	γ_D.	$\gamma-\alpha$.	$\gamma-\beta$	$\beta-\alpha$	Opt. Angle.	Disp.	Orientation.
$Na_2SO_4.10H_2O$	Mon...	1.394	1.396	1.398	0.004	.....	.....	{2V=80° 26′ / 2E=122° 48′(red)}	.....	{Ax.pl.⊥b(010). / X∥b.
$Na_2HPO_4.12H_2O$	Mon...	1.4321	1.4361	1.4373	.0052	0.0012	0.0040	{2V=56° 43′ / 2E=86° 1′}	Distinct. / Inclined	{Ax. pl.b(010). / X∧c=31° in acute∠β.
$Na_2HAsO_4.12H_2O$	Mon...	1.4453	1.4496	1.4513	.0060	.0017	.0043	2V=65° 13′	{Small horizontal.	{Ax.pl.⊥b(010). / X∧c=1° in acute∠β.
$MgSO_4.7H_2O$	Ortho.	1.4326	1.4554	1.4609	.02835	.00550	.02285	{2V=51° 35′ / 2E=78° 20′}	.....	{Ax.pl.c(001). / X∥b.
$NaH_2PO_4.2H_2O$	Ortho.	1.4401	1.4629	1.4815	.0414	.0186	.0228	2V=82° 50′	.....	{Ax.pl.b(010). / X∥c.
$Na_2H_2P_2O_7.6H_2O$	Mon...	1.4599	1.4645	1.4649	.0050	.0004	.0046	{2V=31° 56′ / 2E=47° 31′}	.....	{Ax.pl.⊥b(010). / X∧c=42½ in acute∠β.
Li_2SO_4[a]	Mon...	.....	1.465	.....	Rather weak.	.....	.....	2V=72° 58′	{Small / ρ>ν	{Ax.pl.⊥(010). / X∧c=31° in acute∠β.
$Na_2B_4O_7.10H_2O$	Mon...	1.4468	1.4686	1.4715	.0247	.0029	.0218	{2V=39° 36′ / 2E=59° 23′}	.....	{Ax.pl.⊥b(010). / X∥b; Z∧c=55° 35′ in acute∠β.
$Na_2HP_2O_6.9H_2O$	Mon...	1.4653	1.4738	1.4804	.0151	.0066	.0085	2V=82° 0′	.....	{Ax.pl.⊥b(010). / X∧c=11° in acute∠β.
$K_2H_2P_2O_6.3H_2O$	Ortho.	1.4768	1.4843	1.4870	.0102	.0027	.0075	2V=62° 0′	{Very small... / ρ<ν	{Ax.pl.a(100). / X∥c.
$NaH_2PO_4.H_2O$	Ortho.	1.4557	1.4852	1.4873	.0316	.0021	.0295	{2V=29° 22′ / 2E=44° 14′}	.....	{Ax.pl.b(010). / X∥a.
$ZnSO_4.7H_2O$	Ortho.	1.4620	1.4860	1.4897	.0277	.0037	.0240	2E=70° 23′	ρ>ν	{Ax.pl.c(001). / X∥b.
$NiSO_4.7H_2O$	Ortho.	1.4669	1.4888	1.4921	.0252	.0033	.0219	{2V=41° 56′ / 2E=64° 24′(red).}	.....	{Ax.pl.c(001). / X∥b.
$MgSeO_4.6H_2O$	Mon...	1.4856	1.4892	1.4911	.0055	.0019	.0036	2V=28° 12′	{Strong / ρ>ν	{Ax.pl.b(010). / X∧c=27° in acute∠β.
$MgSO_4.5H_2O$	Tric...	.....	1.491	.....	.....	.....	.....	2V=45° 8′	ρ>ν	X⊥ a plane which deviates little from (010).
$(NH_4)_2Cu(SO_4)_2.6H_2O$[b]	Mon...	.....	{1.494 (red) / 1.502 (blue)}	.....	.....	.....	.....	{2V=71° 21′ / 2E=121° 39′}	Considerable. / ρ>ν	{Ax.pl.b(010). / X∧c=18° 39′; X∧a=87° 27′.
$Na_2Mg(SO_4)_2.4H_2O$ [29]	Mon...	.....	1.500 (red).	.....	.....	.....	.....	{2V=70° 5′ / 2E=119°}	.....	{Ax.pl.(010). / X∧c=45° (red) in acute∠β.
$BeSeO_4.4H_2O$	Ortho.	1.4664	1.5007	1.5027	.0363	.0020	.0343	{2V=26° 43′ / 2E=40° 34′}	.....	{Ax.pl.a(100). / X∥c.
$MgCO_3.3H_2O$[c]	Ortho.	1.495	1.501	1.526	.031	.025	.006	{2V=53° 5′ / 2E=84° 15′}	.....	{Ax.pl.c(001). / X∥a.
$Ba(OH)_2.8H_2O$	Mon...	1.4710	1.5017	Nearly=β.	.....	.....	.0301	{2V=8° 33′ / 2E=20° 9′}	.....	{Ax.pl.⊥(010). / X nearly⊥c(001).
KNO_3	Ortho.	1.3346	1.5056	1.5064	.1718	.0008	.1710	{2V=7° 12′ / 2E=10° 51′}	.....	{Ax.pl.a(100). / X∥c.
$Ce_2(S_2O_6)_3.15H_2O$	Tric...	.....	1.507	.....	.....	.....	.....	2V=88° 52′	{Weak / ρ>ν}	Both axial figures visible through c(001).

$KClO_3$[b]	Mon...	1.440	1.515	1.525				2V=28° 15′ 2E=43°	$\nu > \rho$	Ax.pl.⊥b(010). X∧c=57½ in obtuse ∠β.
$NaHCO_3.Na_2CO_3.2H_2O$	Mon...		1.5073		Strong.			2V=76° 16′		Ax.pl.∧c(001)=51° in obtuse ∠β. X∥b.
$Cs_2Ni(SO_4)_2.6H_2O$	Mon...	1.5087	1.5129	1.5162	.0075	.0033	.0042	2V=87° 21′		Ax.pl.b(010). X c=24° 7′; X a=82° 55′.
$Na_2Ca(CO_3)_2.5H_2O$	Mon...	1.4435	1.5156	1.5233	.0798	.0077	.0721	2V=35° 4′ 2E=52° 4′		Ax.pl.⊥b(010). X∥b.
$K_2Ca(SO_4)_2.H_2O$	Mon...	1.5000	1.5170	1.5183	.0183	.0013	.0170	2V=26° 44′ 2E=44° 42′		Ax.pl.⊥(010). X c=87° 14′.
$CoSeO_4.6H_2O$	Mon...		1.5225	1.5227		.0002		2V=7° 13′ 2E=11° 0′	$\rho > \nu$	Ax.pl.b(010). X∧c=34° 42′ in acute ∠β.
$K_2Cu(SeO_4)_2.6H_2O$[c]	Mon...	1.5096	1.5235	1.5387	.0291	.0152	.0139	2V=88° 12′		Ax.pl.b(010). X∧c=10° 53′; X∧a=92° 26′.
$K_2H_2P_2O_6.2H_2O$	Mon...	1.4893	1.5314	1.5363	.0470	.0049	.0421	2V=36° 9′	Very weak $\rho < \nu$	Ax.pl.⊥b(010). X∧c=36° 30′ in acute ∠β.
$(NH_4)_2Cu(SeO_4)_2.6H_2O$	Mon...	1.5213	1.5355	1.5395	.0182	.0040	.0142	2V=55° 24′ 2E=91° 6′		Ax.pl.b(010). X∧c=12° 20½′; X∧a=93° 12′
$(NH_4)HCO_3$	Ortho.	1.4227	1.5358	1.5545	.1318	.0187	.1131	2V=41° 38′ 2E=66° 10′		Ax.pl.b(010). X∥a.
$2MgHBO_3.MgSO_4.3\frac{1}{2}H_2O$	Ortho.	1.5272	1.5362	1.5443	.0171	.0081	.0090	2V=86° 52′		Ax.pl.(010). X∥c.
$CuSO_4.5H_2O$	Tric...	1.5140	1.5368	1.5433	.0293	.0065	.0228	2V=56° 2E=93°	$\rho < \nu$	
$BaSiO_3.6H_2O$	Ortho.	1.542	1.548	Nearly=β.			.006	2V=39° 40′ 2E=59° 40′		Ax.pl.b(010). X∥a.
$MgCrO_4.7H_2O$	Ortho.	1.5211	1.5500	1.5680	.0469	.0180	.0289	2V=75° 28′	$\rho < \nu$	Ax.pl.c(001). X∥b.
$NaH_2AsO_4.H_2O$	Ortho.	1.5382	1.5535	1.5607	.0225	.0072	.0153	2V=67° 57′ 2E=120° 28′		Ax.pl.b(010). X∥c.
$NaBePO_4$	Ortho.	1.5520	1.5579	1.5608 (?)	.0088	.0029	.0059	2E=121° 1′		Ax.pl.(100). X∥c.
Cs_2SO_4	Ortho.	1.5598	1.5644	1.5662	.0064	.0018	.0046	2V=65° 20′ 2E=115° 40′		Ax.pl.b(010). X∥c.
$CdSO_4 8/3H_2O$	Mon..		1.565					2V=88° 9′		Ax. pl.⊥b(010). X∥b.
Li_2CO_3	Mon..	1.428	1.567	1.572	.144	.005	.139	2E=21°		Ax. pl. nearly ∥ a(100). X almost exactly ∥c.
$NH_3KPt(Cl_3.H_2O$ [f]	Ortho.	1.5438	1.5754				.0316	2V=64°		Ax. pl. a(100). X∥c.
$K_4Fe(CN)_6.3H_2O$	Mon..		1.5772					2V=78° 10′	Weak $\rho > \nu$	Ax. pl. ⊥(010). X∧c=31° 50′ in obtuse ∠β.
$K_4Ru(CN)_6.3H_2O$	Mon..		1.5837					2V=54° 0′		Ax. pl.⊥(010). X∧c=32° 10′ in obtuse ∠β.
$MgPt(CN)_4.C_3H_8O_3.5H_2O$	Mon..		1.584					2V=17° 39′		Ax. pl. b(010). X∧c=30° in obtuse ∠β.

[a] Bolland gives 1.49, 1.48 for n.
[b] X reddish, Y dark blue, Z clearer blue. Indices: personal communication, E. T. Wherry.
[29] Bolland gives 1.485, 1.49 for n (?).
[f] A yellowish red, B reddish yellow, C deep yellow or red.
[c] α calculated.
[d] Bolland gives 1.47 and 1.54 for n.
[e] If indices are correct is positive, for $\gamma-\alpha>\beta-\alpha$.

TABLE 5.—*Biaxial negative substances*—Continued.

Substance.	System.	α_D.	β_D.	γ_D.	$\gamma-\alpha$.	$\gamma-\beta$	$\beta-\alpha$	Opt. angle.	Disp.	Orientation.
$CaHAsO_4.2H_2O$	Mon.	1.5825	1.5891	1.5937	.0112	.0046	.0066	2V=79° 24′		Ax. pl. ⊥b(010). X∧c=69° 40′ in obtuse ∠β.
Cs_2SeO_4	Ortho.	1.5989	1.5999	1.6003	.0014	.0004	.0010	2V=71° 49′ 2E=132° 20′		Ax. pl. c(001). X∥b.
$K_2Li_2Fe(CN)_6.3H_2O$ *g*	Mon.	1.5883	1.6007	1.6316	.0433	.0309	.0124	2V=65° 56′		Ax. pl. (010). X∧c=44° 10′ in acute ∠β.
$K_4Os(CN)_6.3H_2O$	Mon.		1.6071					2V=47° 0′		Ax. pl. ⊥(010). X∧c=30° 10′ in obtuse ∠β.
$CaPtCy_4.5H_2O$	Ortho.	1.6226		1.7643	.1416			2E=86½°		X∥c.
$NH_4PtCl_3.C_2H_4.H_2O$	Mon.	1.623		1.702				2E=32½°	$\nu>\rho$	Ax. pl. ⊥(010). X∧c=8½° in obtuse ∠β.
$KPtCl_3.C_2H_4.H_2O$ *h*	Mon.	1.627		1.717				2E=47°		Ax. pl. ⊥(010). X∧c=22° in obtuse ∠β.
$CaPO_4(BeOH)$	Mon.		1.630					2V=72°	$\rho>\nu$	Ax. pl. (010). X∧c=2½° in acute ∠β.
$Na_6Mo_5P_2O_{23}.14H_2O$	Ortho.	1.5962	1.6411	1.6520	.0558	.0109	.0449	2V=51° 18′ 2E=90° 35′		Ax. pl. a(100). X∥b.
$BaCdCl_4.4H_2O$	Tric.		1.651		Not strong.			2H=69° 33′	$\rho<\nu$	X nearly ⊥m(110). Ext. angle on (110)=10⅔°, on (010)=5¼°, on (100)=2½°, on (110)=4½°.
$(NH_4)_4Ru(NO)(OH)Cl_6H_2O$	Mon.		1.6548					2V=56° 20′	Very weak $\rho<\nu$	Ax. pl. b (010). X∧c=44° 20′ in acute ∠β.
$Ca(BO_2)_2$	Ortho.	1.540	1.656	1.682	.142	.026	.116	2E=90° 24′		Ax. pl. c(001). X∥a.
$Ag_2S_2O_6.2H_2O$	Ortho.	1.6272	1.6573 (C)	1.6601	.0329	.0028	.0301	2V=33° 21′ 2E=56° 48′		Ax. pl. c(001). X∥b.
$Co_3(AsO_4)_2.8H_2O$ *i*	Mon.	1.6263	1.6614	1.6986	.0723	.0372	.0351			X∥b.
$SrCO_3$	Ortho.	1.5155	1.664	1.666	.150	.002	.148	2V=6° 22′ 2E=10° 36′		Ax. pl. (100). X∥c.
$K_2HgCl_4.H_2O$	Ortho.	1.648	1.678	1.699	.051	.021	.030	2V=78° 25′	Very considerable. $\rho>\nu$.	Ax. pl. c(001). X∥a.
$Na_3AsS_4.8H_2O$	Mon.		1.6802		Weak.			2V=87° 44′		Ax. pl. b(010). X∧c=81° 11′ in obtuse ∠β.
$CaCO_3$	Ortho.	1.5299	1.6809	1.6854	.15543	.00443	.15100	2V=18° 11′ 2E=30° 52′		Ax. pl. (100). X∥c.
$CaBa(CO_3)_2$	Mon.	1.525	1.684	1.686	.161	.002	.159	2E=23° 15′(red) 2E=22° 47′(blue)		Ax. pl. ⊥(010). X∧c=64¼° in obtuse ∠β.
$BaCdBr_4.4H_2O$	Tric.		1.702					2V=70° 13′	$\rho<\nu$	
K_2CrO_4	Ortho.		1.7131 (C)					2V=51° 40′ 2E=97° 30′	Weak. $\rho>\nu$	Ax. pl. a(100). X∥b.
$CaBe_3(Mn, Fe, Mg)_2(SiO_4)_3$	Tric.	1.7148	1.7202	1.7253	.0105	.0051	.0054	2V=83° 29′	Very small.	Ax. pl. nearly ⊥c(100). X almost ⊥c(001).
$CaMnSiO_4$	Ortho.	1.686	1.722	1.735	.049	.013	.036	2V=60° 51′ 2E=121° 30′		Ax. pl. c(001). X∥b.

$Mn_3B_4O_9$	Tric.	1.617	1.738	1.776	.159	.038	.121			X∧⊥c(001)=27° 43′. X∧⊥a(100)=29° 11′.
$BaCO_3$	Ortho.		1.740					2E=26° 30′	Scarcely perceptible. ρ>ν	Ax. pl. (010). X∥c.
$CuPO_4(CuOH)$	Ortho.		1.743					2V=81° 8′		Ax. pl. c(001). X∥b.
$Ba_2W_{12}SiO_{40}.16H_2O$	Mon.		1.816		Rather strong.			2V=78° 44′	Very strong... ρ>ν	Ax. pl. ⊥b(010). X∥b.
$TlNO_3$	Ortho.	1.817						2E=111° 16′ (red). 2E=114° 59′ (blue)		Ax. pl. b(010). X∥c.
$PbSO_4.Cu(OH)_2$	Mon.	1.8090	1.8380	1.8593	.0503	.0213	.0290	2V=79° 59′		Ax. pl. ⊥(010). X∧c=24° in acute ∠β.
$Pb(SO_4)_4(PbOH)_6.2Cu(CO_3)_4(CuOH)_6$.	Ortho.		1.846 (red)					2V=82° 37′		Ax. pl. (100).
$Cu_2(OH)_3Cl$	Ortho.	1.831	1.861 (green)	1.880	.049	.019	.030	2V=74° 56′		Ax. pl. (100). X∥b.
$(CuOH)_2CO_3$	Mon.		1.87 1.88					2V=44° 7′ 2E=89° 18′ (yellow).		Ax. pl. (010). X∧c=23½° in obtuse ∠β.
Tl_2SeO_4	Ortho.	1.9493	1.9592	1.9640	.0147	.0048	.0099	2V=72° 58′		α∥b,β∥c, γ∥a. X∥b; Z∥a. Ax. pl. c(001).
$PbCO_3$	Ortho.	1.8037	2.0763	2.0780	.2743	.0017	.2726	2V=8° 14′ 2E=17° 8′		Ax. pl. (010). X∥c.
$Pb(OH)Cl$ [j]	Ortho.	2.0767	2.1161	2.1580	.0813	.0419	.0394	2V=81° 32′		Ax. pl. b(010). X∥a.
$Pb(Tl, Ag)_2(AsS_2)_4$	Ortho.	3.078	3.176	3.188	.110	.012	.098	2V=37° 34′		Ax. pl. (100). X∥b.
$AgAsS_2$	Mon.		Mean n=3.27					2V=65°		Ax. pl. (010). X∧⊥(100)=6½° in obtuse ∠β.

[g] If indices are correct, is positive.
[i] If indices are correct, is positive.
[h] Pleochroism weak. b greenish, all others brownish.
[j] If indices are correct, is positive.

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